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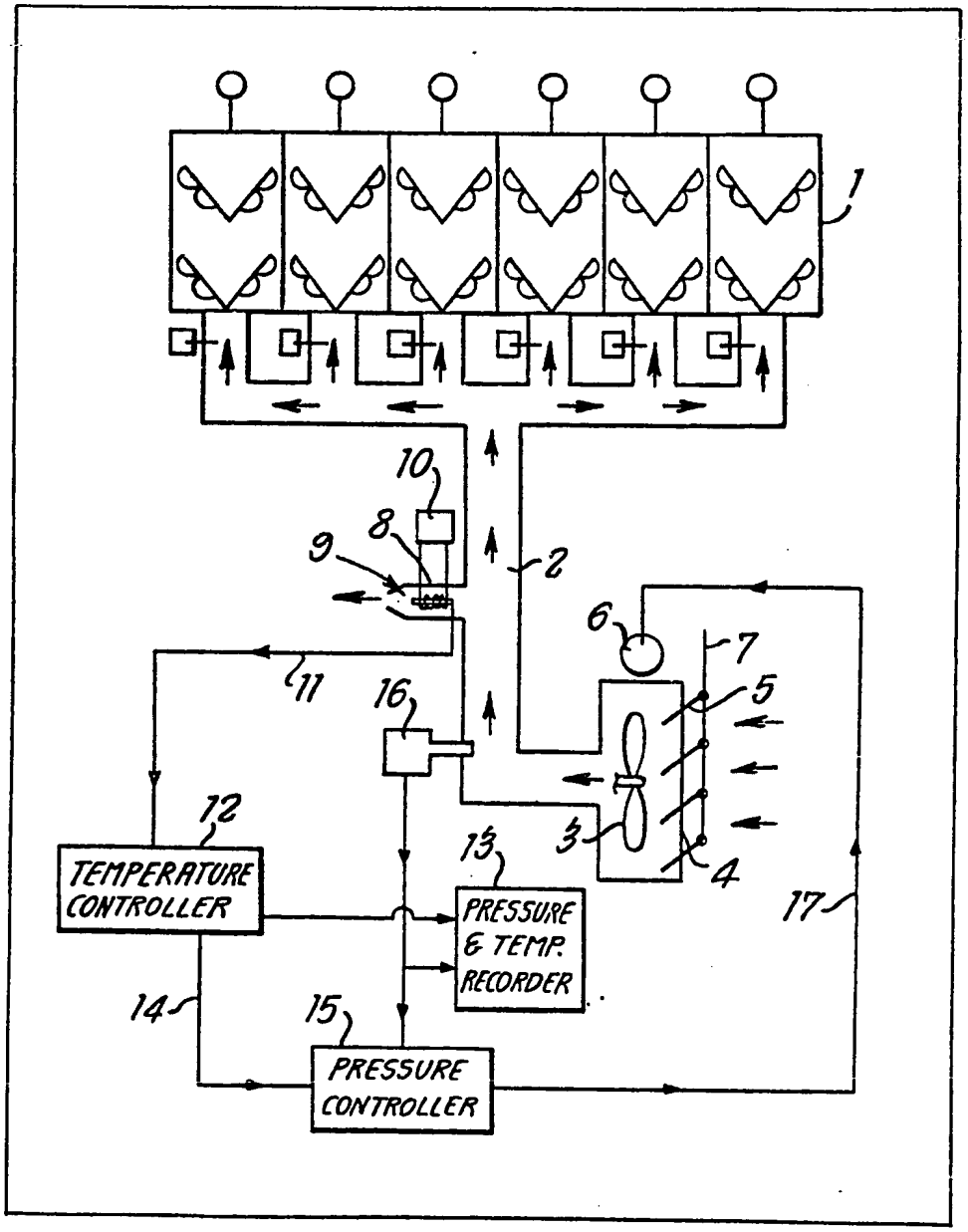
(54) Controlling cooling systems

(57) A cooling control system is described which is of particular value in controlling the cooling of various parts of an independent section glass-forming machine. The control of the cooling air which passes through a duct is effected by a combination of a measurement of the cooling capacity of the air (determined by locating in the air flow in or near the duct a heated body and measuring its surface temperature) and the pressure of the cooling air supply. The air flow through the duct is increased or decreased to maintain the pressure in the duct substantially at a pressure set point which in turn depends on the temperature measured at the surface of the body set in the cooling air stream.



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SPECIFICATION

Controlling cooling systems

This invention relates to controlling cooling systems.

The present invention is particularly applicable to the cooling of parts of glass container manufacturing machines, for example of the type known as "I.S." machines. The invention is however applicable to the control of cooling in machines operating analogously in other areas of manufacture or heat treatment.

In the manufacture of glass containers, a gob of glass from a glass making furnace is successively shaped and blown in a number of different moulds until it reaches its final desired form. During this time, the glass is cooled giving up its heat to the moulds which are in turn cooled by blowing air over them. The moulds may be constructed e.g. with integral vanes or the like to promote the cooling effect. It is common practice in such machines to provide a single cooling air supply which is subsequently divided up over the various sections of the machine and it is known to control the overall flow of such cooling air in order to compensate for variations which occur in practice.

It is important to compensate for such variations since if they are not taken into account, the amount of cooling undergone by each particular mould changes and either insufficient or excess cooling will disturb the manufacturing process leading to malformed glass articles which have to be scrapped.

There are two major sources of variation in the conditions. One source over which it is possible to exercise no effective control is the weather. Both the ambient temperature of the air and its humidity change diurnally and seasonally to a substantial extent and in addition to these two variations there is the normal variation between good weather and bad weather. The other major change in the overall conditions under which the machine runs rises from shutting down or opening up one or more sections in a multisection machine.

British Patent Specification 1427720 addresses these problems and discloses a system in which cooling air supplied to e.g. a glass container manufacturing machine of the I.S. type is caused to flow over a sensor the output of which is used to control the flow of cooling air. The sensor is of the type comprising a body heated to a temperature of the same order as that of the parts of the machine to be cooled and a temperature sensing device measuring the actual temperature of the body. If that measured temperature rises, i.e. the cooling effect of the air becomes less, the air flow may be increased to compensate and bring the cooling effect back into the desired region. Likewise if the sensed temperature of the body drops, the cooling air flow may be restricted so that overcooling of the corresponding mould parts is avoided.

The system described in Specification 1427720 should in theory work to compensate for relatively small scale fluctuations in the temperature and pressure and humidity of the ambient air, but in practice, such systems work unsatisfactorily and are wholly insufficient when major changes occur in the overall amount of cooling that is required when one or more sections of the machine are shut down or opened up.

According to the present invention there is provided a cooling control system in which air for cooling is passed through a duct from the open air to the areas to be cooled which system comprises a body located in the cooling air stream, means to supply heat to the body at a constant rate, means to measure the temperature of a surface of the body cooled by the air stream, means for generating a pressure set point dependent upon the temperature so measured, means for measuring the pressure of air flowing in the duct and means for increasing or decreasing the flow of air through the duct to maintain the pressure in the duct substantially at the pressure set point.

In such a control system the interrelationship of the cooling capacity of the air and the pressure of the cooling air supply are combined in a fashion giving accurate control with a very fast response time. The control of the air flow through the duct is effected basically by a pressure controller so that while the cooling properties of the incoming air remain the same, the set point for the pressure controller remains the same and the means for passing the air through the duct are adjusted rapidly when sections of the machine are opened or closed. Slower acting changes such as the drop in air temperature during the evening are smoothly and gradually compensated for as they occur by a change in the pressure set point generated by the change in the cooling properties of the air determined by the temperature sensor.

The air is preferably passed through the duct by blowing it through the duct with a suitable fan and the pressure in the duct may be controlled either by controlling the fan directly and/or by throttling the air input to the fan. A convenient and highly preferred way of doing this is to draw in the air to the fan via a system of louvres or a sliding gate type valve where the inclination of the vanes or position of the sliding gate respectively may be adjusted using a suitable motor and linkage.

In such a case, it is desirable to provide that the actual number of vanes in a set of louvres which are opened at any time can be varied. This allows adjustments to be made over a very wide range of conditions, e.g. to match the number of sections of the I.S. machine actually in use.

Preferably the system is arranged that the operative vanes of a set of louvres operate over an angular range of 15 to 45° relative to the plane of the set of louvres, i.e. around an average opening of about 30°.

In order to enable rapid adjustment of the air flow when sections are taken out of operation or put back into operation, each vane is preferably provided with means enabling it to be decoupled from an actuating arm connected to all the operational vanes, and fixed in a closed position.

On starting up a section of the machine, such a closed vane may be quickly opened and r connected to the control arm, whereafter return to balanced controlled running occurs rapidly. A convenient method of adjustment of the vanes is to provide, on the end of each vane, a quadrant with an arcuate slot which runs over a fixing spigot. The quadrant may be fixed to the fixing spigot e.g. by a threaded bolt, to fix the vane in the closed (or any intermediate) position, or the same bolt may be used to act as a pivot on an actuation arm for the vanes.

Specification 1427720 gives details of devices for measuring the cooling effect of cooling air. Such devices consist of a body which is heated at a constant heat input. Air is blown over the body in appropriate fashion to correspond with cooling air blown over the surfaces to be cooled e.g. mould parts on a glass forming machine. The temperature of the body is measured e.g. using an appropriate thermocouple and the actual temperature of the body at constant heat input is a measure of the cooling effectiveness of the cooling air stream.

The various individual components of the system such as the means for measuring the pressure in the air duct and the means for controlling air flow through the duct to regulate that pressure are standard and may be selected in known fashion to suit the particular circumstances of use. Naturally the system may be associated with appropriate recording or monitoring means to record the changes in temperature and/or pressure and/or humidity of the cooling air.

By way of illustration, the accompanying drawing shows diagrammatically one form of control system applied to a glass container manufacturing machine.

Referring to the drawing, cooling air is supplied to a glass container manufacturing machine 1 of the I.S. type via a duct 2 from a high capacity fan 3. The inlet area of the fan is covered by a louvred box 4 the position of each of the louvres 5 of which is controlled by a motor 6 via a suitable linkage 7.

Located in a branch 8 from duct 2 is a cooling effect transducer indicated generally at 9. This consists of a body whose materials and surface characteristics approximate to those of the mould parts of the machine 1 to be cooled. Heat is supplied internally of that body by a resistance heater driven by a constant voltage unit 10. In contact with the external surface of the heated body is a thermocouple connected via a lead 11 to a temperature controller 12 and to the appropriate input of a temperature and pressure recorder 13. Controller 12 is provided with a manual set point device enabling the desired cooling effect to be set. This is suitably calibrated in degrees Centigrade but its absolute value is of no particular importance. Normally, the surface temperature measured by the thermocouple will be between the surface temperature of the hottest mould parts being cooled in machine 1 and the surface temperature of the coolest mould parts being cooled in machine 1.

The output of the temperature controller 12 is fed via a lead 14 to a controller 15 of known type, the input from lead 14 being taken as the set point for controller 15. The other input of controller 15 comes from a pressure transducer 16 which senses the pressure in duct 2. The output of controller 15 is fed via a lead 17 to motor 6 and the system arranged that if the detected pressure is less than the desired pressure, motor 6 acts to open louvres 5 wider while if the detected pressure is higher that that desired, motor 6 is operated to close down louvres 5 until the desired pressure is achieved. The output of transducer 16 is also fed to the temperature and pressure recorder 13 so that a constant record of operation is produced.

CLAIMS

1. A cooling control system in which cooling air is passed through a duct from the open air to the areas to be cooled, which system comprises a body located in the cooling air stream, means to supply heat to the body at a constant rate, means to measure the temperature of a surface of the body cooled by the cooling air stream, means for generating a pressure set point dependent upon the temperature so measured, means for measuring the pressure of air flowing in the duct, and means for increasing or decreasing the flow of air through the duct to maintain the pressure in the duct substantially at the pressure set point.

2. A cooling control system according to claim 1 wherein the air flow through the duct is controlled by a pressure controller.

3. A cooling control system according to claim 1 or 2 wherein the air is passed through the duct by blowing it through the duct with a fan and the pressure in the duct is controlled by controlling the fan directly and/or by throttling the air input to the fan.

4. A cooling control system according to claim 3 wherein the pressure in the duct is controlled by drawing in air to the fan via a system of adjustable louvres or adjustable sliding gate valves.

5. A cooling control system according to claim 4 wherein the louvres or valves may be selectively decoupled.

6. A cooling control system substantially as hereinbefore described with reference to the accompanying drawings.

7. An independent section glass-forming machine provided with a cooling control system according to any one of the preceding claims.

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